National Institute of Environmental Health Sciences

Malaria control under unstable dynamics: Reactive vs. climate-based strategies

Author(s): Baeza A, Bouma MJ, Dhiman R, Pascual M
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Abstract:

In areas of the world where malaria prevails under unstable conditions, attacking the adult vector population through insecticide-based Indoor Residual Spraying (IRS) is the most common method for controlling epidemics. Defined in policy guidance, the use of Annual Parasitic Incidence (API) is an important tool for assessing the effectiveness of control and for planning new interventions. To investigate the consequences that a policy based on API in previous seasons might have on the population dynamics of the disease and on control itself in regions of low and seasonal transmission, we formulate a mathematical malaria model that couples epidemiologic and vector dynamics with IRS intervention. This model is parameterized for a low transmission and semi-arid region in northwest India, where epidemics are driven by high rainfall variability. We show that this type of feedback mechanism in control strategies can generate transient cycles in malaria even in the absence of environmental variability, and that this tendency to cycle can in turn limit the effectiveness of control in the presence of such variability. Specifically, for realistic rainfall conditions and over a range of control intensities, the effectiveness of such 'reactive' intervention is compared to that of an alternative strategy based on rainfall and therefore vector variability. Results show that the efficacy of intervention is strongly influenced by rainfall variability and the type of policy implemented. In particular, under an API 'reactive' policy, high vector populations can coincide more frequently with low control coverage, and in so doing generate large unexpected epidemics and decrease the likelihood of elimination. These results highlight the importance of incorporating information on climate variability, rather than previous incidence, in planning IRS interventions in regions of unstable malaria. These findings are discussed in the more general context of elimination and other low transmission regions such as highlands.

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Resource Description

Climate Scenario :

specification of climate scenario (set of assumptions about future states related to climate)

Other Climate Scenario

Other Climate Scenario: author defined scenarios

Exposure :

weather or climate related pathway by which climate change affects health

Ecosystem Changes, Precipitation, Temperature

Temperature: Fluctuations

Geographic Feature: ☑

resource focuses on specific type of geography

Other Geographical Feature

Other Geographical Feature : arid climate

Geographic Location: ☑

resource focuses on specific location

Non-United States

Non-United States: Asia

Asian Region/Country: India

Health Impact: ☑

specification of health effect or disease related to climate change exposure

Infectious Disease

Infectious Disease: Vectorborne Disease

Vectorborne Disease: Mosquito-borne Disease

Mosquito-borne Disease: Malaria

Intervention: ☑

strategy to prepare for or reduce the impact of climate change on health

A focus of content

Medical Community Engagement: ☑

resource focus on how the medical community discusses or acts to address health impacts of climate change

A focus of content

Mitigation/Adaptation: ☑

mitigation or adaptation strategy is a focus of resource

Adaptation

Model/Methodology: ☑

type of model used or methodology development is a focus of resource

Methodology, Outcome Change Prediction

Resource Type: ☑

format or standard characteristic of resource

Research Article, Research Article

Timescale: ☑

time period studied

Time Scale Unspecified

Vulnerability/Impact Assessment: ☑

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content